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### RECOMPARISON OF LENGTH STANDARDS

In the opening paragraph of an article on the Bureau's work in metrology and mechanics, published in the *Scientific Monthly* for June 1933, Dr. Lyman J. Briggs calls attention to the fact that the national standards of length and mass "constitute the basis of the whole system of weights and measures in the United States. \* \* \* From the fundamental units of length, mass, and time (the second) all other units used in science and engineering may be derived, with the exception of the unit of difference in temperature."

Line standards of length sent to the Bureau for checking are not compared directly with the National Standard, but with certain high-grade laboratory standards which, in turn, are periodically checked against one or more of a small group of bars that are known to be extremely stable and the lengths of which have been determined by direct comparison with the National Standard.

Recently, Benjamin L. Page of the length section redetermined the total lengths of two of the Bureau's invar laboratory meter bars—Meter 39 and

Meter 752. He found that the former is still lengthening after 41 years of use at the Bureau, whereas the latter continues to shorten, as it has done ever since it was received in 1931. Platinum-iridium Meter 4 (a bar made of an earlier alloy, but having approximately the same composition as the National Standard, Meter 27) was used as the basis of the standardization, each of the laboratory standards having been compared with this platinum-iridium bar. Meter 39 and Meter 752 were then compared directly, and agreement to 0.01 micron (approximately four one-hundred-thousandths of an inch) was found with the computed difference in length.

This gives renewed assurance of the accuracy of all the Bureau's work.

### RADIOMETRIC METHOD OF TESTING ULTRAVIOLET SCREENING PROPERTIES OF SUNBURN PREVENTIVE CREAMS

The number of salves, creams, and lotions available for protecting the skin from sunburn is legion. They are of three types: (1) Those that contain substances highly opaque to ultraviolet rays of wavelengths shorter than

<sup>1</sup> Published with approval of the Director of the Budget.

3250 A, (2) those that contain substances that diffusely reflect these rays, and (3) those containing substances that do both. Assuming that they meet the requirements of not holding dust and sand, freedom from rancidity, not interfering with transpiration, and not irritating to or soaking into the skin, there remains the question of their efficiency in protecting the skin from sunburn.

Sunburn is produced by ultraviolet solar rays of wavelengths of about 3250 A and shorter—the maximum burning action being at wavelength 2967 A.

The evaluation of light-protective substances, in general, by the physiological (erythema) test; also by the measurement of their spectral absorption in the region of 2900 to 3250 A is slow and tedious. Fortunately, the Cd-photoelectric cell, which has a spectral response that for all practical purposes coincides with the spectral erythema (sunburn) response, is readily available as a radiometer, at least as an instrument for sorting out the relatively good from the optically unsatisfactory sunburn preventive creams. W. W. Coblenz, chief of the Bureau's radiometry section, finds that the particular Cd-photoelectric cell that meets the requirements as an ultraviolet radiometer, suitable for this purpose, is constructed in the form of an opaque, pear-shaped bulb (GE type FJ-135). The whole interior of this bulb is photosensitive and hence integrates the ultraviolet radiation of wavelengths 3250 A and shorter that enters through the window, which is covered with a diffusing screen, as shown in figure 2 of Bul. Am. Meteorol. Soc. 18, (November 1937); also figure 1 of J. Research NBS 20, 185 (February 1938) RP-1075 and figure 6 of 22, 573 (May 1939) RP1207.

The opacity of the sunburn preventive cream (pressed between two thin plates of quartz, Corning Correx-D No. 970, or high-silica glass No. 791) is determined by holding it over the diffusing window of the Cd-photocell, which, as already mentioned, integrates the diffusely incident radiation.

The auxiliary measuring instrument, which must be capable of measuring transmissions accurately to 0.1 percent, is a microammeter and amplifier (BS J. Research 12, 231 (February 1934) RP647), a high-resistance, high-sensitivity galvanometer, or other suitable meter. The source is a hot quartz mercury arc or carbon-arc lamp covered with a Correx-D window.

## BUILDING CODES OF THE FUTURE

In a talk on Building Codes of the Future, delivered at a forum session of the annual meeting of the National Fire Protection Association in Philadelphia on May 10, George N. Thompson, chief of the building codes section of the Bureau, described an earlier meeting held nearly a generation ago at which remedies for defects in building codes were discussed. Far from regarding this as evidence that building codes will always be a problem, Mr. Thompson pointed out that the accumulation of results of research, coupled with a better understanding of legal and technical questions gained through committee discussions, has made it possible to place codes on a sound basis. He conceded that adjustment of conflicting views was still necessary, since code requirements must reflect expert opinion as well as established facts, but he stated that appreciation of the good that can be done in the public interest by reaching agreement on essentials would inevitably overcome any such differences. With the advantages that can be counted on in present work, he expressed confidence that future requirements can be developed providing general satisfaction, and that the next generation will not have occasion to look back on present-day meetings with the task of building code regeneration still before it.

## COMMERCIAL STANDARD FOR BITUMINIZED-FIBRE DRAIN AND SEWER PIPE

It is predicted that many products used as substitutes to conserve critical materials during the present emergency will continue to enjoy popularity in the post-war era. Among these is bituminized-fibre pipe, long employed as a protective conduit for underground electric cables, and now being used to relieve the shortage of more critical materials for drainage and sewage disposal. Made of coal-tar pitch reinforced with an interwoven fibrous structure, it possesses unusual strength and durability. Bearing these facts in mind, one manufacturer reasoned that the ability of this pipe to exclude water should enable it also to contain and convey water just as effectively.

Some of the desirable attributes claimed for the material are light weight (an important transportation and labor item), resistance to corrosion, low installation costs, and the

fact that roots of trees, which often enter and clog sewers, are said to shun the coal-tar pitch in the pipe. It has the ability to bend with shifting earth instead of cracking.

Commercial Standard CS116, which has just been released, establishes construction and performance requirements that the industry believes will insure a satisfactory pipe for many drainage purposes.

The standard covers material and dimensions of pipe, couplings, and bends in sizes ranging from 2 to 8 inches inside diameter, and in 5-foot and 8-foot lengths. The requirements cover wall thicknesses, crushing strength, beam strength, resistance to corrosion and heat, and the details of joints. Close control of joint details permits products of different manufacturers to be used interchangeably. Methods of test to demonstrate compliance with requirements, including joint tightness, are given. The wording of a guarantee by the manufacturer is included.

The pamphlet also contains a list of producers, distributors, and users who have accepted the specification as their standard of practice, the membership of a standing committee to recommend revision when necessary, etc.

Copies of CS116-44 can be purchased from the Superintendent of Documents, Government Printing Office, Washington 25, D. C. The price is 5 cents.

#### DEVELOPMENT OF BUILDING CODE STANDARDS

In an article by George N. Thompson, chief of the Bureau's section on building codes, prepared for publication in "Bay State Builder," it is pointed out that because of the widespread distribution of goods and services in the construction industry, the influence of local building codes extends beyond the borders of the communities to which they apply. Mr. Thompson believes that a useful service would be performed by developing a series of related standards produced on a national basis and made available to State and local committees engaged in building-code work. He calls attention to a series of this kind now being developed under the procedure of the American Standards Association.

#### SELF-IGNITION OF WOOLEN MATERIALS

Many combustibles become heated and take fire spontaneously under conditions

that are sometimes met with in shipping or storage, if the surrounding temperatures go too far above normal. This problem has been studied extensively in relation to oils, fats, vegetable fibers, coal, and many other materials. Little is known about the behavior of woolen materials because their reaction differs from that of most other combustibles. If the material is heated to a point where the fibers melt, ignition does not take place below temperatures of about 525° C, at which point the material gives off gases that are ignited.

At the Bureau, the behavior of woolen materials has been studied in the 1,000-ml ignition flask designed for self-ignition determinations. It is found that when the air supply is properly regulated, self-heating and ignition occur from an initial temperature of only 215° C. The material for this test was from khaki-colored blankets containing less than 1 percent of cotton and some wool fat. No ignition took place below 525° C with samples of pure scoured wool.

#### PROPERTIES OF HOUSEHOLD BLANKETS

An investigation of blankets, recently completed by H. F. Schiefer, H. T. Stevens, P. B. Mack, and P. M. Boyland, in the Bureau's textile section, was undertaken to provide adequate test methods and to supply basic data as a guide for a performance specification. The results are given in RP1589 in the June number of the Journal of Research.

Blankets are an essential article in many places of abode, and in war they form a vital part of the protective clothing of the soldier, sailor, and marine on battle fronts and in training camps. They furnish shelter to the wounded and to those forced to take to lifeboats and life rafts at sea. In time of peace, blankets are a first consideration for camping and other outdoor recreation and sport. In a major emergency they provide temporary shelter to the unfortunate victims whose lives may depend upon the warmth afforded by blankets.

Although blankets are so important in war and in peace, adequate methods for testing them and essential information about their performance characteristics have not been available. Changes in the softness, resiliency, flexibility, fluffiness, and warmth of blankets often result from excessive mechanical action during washing and too high and uncontrolled temperature and alkalinity of the wash waters.

In the investigation at the Bureau, the fiber composition, weight, thickness, compressibility, compressional resilience, thermal transmission, air permeability, breaking strength, and shrinkage of 156 different blankets were measured. The effects of laundering; of laundering and renapping; of laundering, renapping, and abrasion; of dry cleaning and renapping; and of dry cleaning, renapping, and abrasion on these properties of a large number of blankets are brought out in the report. A linear relationship was found between the compressional resilience and the wool content of cotton-wool blankets. Thermal transmission was found to be independent of the kind of fiber, but its reciprocal was found to be related linearly to the thickness. The thermal transmission, computed by means of the equation  $1/T = 3.0 t_{0.1} + 0.63$ , where  $T$  is the thermal transmission in Btu/(°F hr ft²), and  $t_{0.1}$  is the thickness in inches at a pressure of 0.10 lb/in.², was found to agree with the measured values within  $\pm 10$  percent 95 times out of 100. Empirical relationships were also found among thermal transmission, thickness at 1.0 lb/in.², and compressibility; and among thickness at 0.10 lb/in.², compressibility, and weight. The relation between breaking strength and weight, and that between breaking strength and compressibility, are discussed. Minimum requirements are suggested for the properties of blankets for use in a performance specification.

#### PURIFICATION OF SUBSTANCES BY SLOW FRACTIONAL FREEZING

Residents of Maine are reported sometimes to have employed their native ingenuity to make a potent liquor merely by allowing a barrel of hard cider to stand out of doors in freezing weather until a substantial part of the water has frozen as a thick coating of ice on the inside of the barrel. Thereafter the remaining liquid, now greatly concentrated, is drawn off.

The same physical principle is involved in the techniques for purifying chemical substances by slow fractional freezing that are described by Frank W. Schwab and Edward Wichers in the June number of the *Journal of Research* (RP 1588). Two variations of this method were applied to the purification of benzoic acid (a substance commonly used as a chemical standard) and were found much more effective than previous trials of crystallization

from solvents. In the first of these techniques, a cylindrical vessel containing the fused substance is slowly lowered, by means of a floating table, through a heating coil. Freezing begins at the bottom and progresses upward as the tube emerges slowly from the heated zone. The impurities in the substance tend to remain in the liquid, which is constantly stirred, and thus are concentrated in the portion which freezes last. After the whole mass is frozen, the upper end is cut off and discarded.

In the second technic, which is applicable to larger quantities of material and which also provides a greater area of solid surface in proportion to the quantity of material to be frozen, a spherical flask is filled with the molten substance and is then buried in highly efficient thermal insulation. Freezing begins on the wall of the flask and is allowed to progress slowly inward until the desired fraction has solidified. During this period the liquid is constantly stirred to prevent accumulation of impurities at the boundary between the solid and the liquid. The portion of liquid which is to be discarded is drawn off with a siphon.

The second technic was also used for preparing highly purified acetanilide, another substance issued by the Bureau as a chemical standard. This substance, like benzoic acid, freezes well above ordinary temperatures, so that the flask needed only to be well insulated to control the rate of freezing. The second technic can also be applied to substances freezing below room temperatures by refrigerating the outside of the container.

#### LAMINAR FLOW AT THE INTERFACE OF TWO LIQUIDS

Liquids often move in layers having different densities, ocean and atmospheric currents being well-known cases of stratified flow. The mixing that generally accompanies such motion is of great geophysical significance, yet knowledge is lacking of exactly how the mixing takes place, or of the forces that tend to prevent it.

Two economically important manifestations or occurrences of stratified flow are found in water. One of these is the motion of muddy water through large reservoirs. Under certain circumstances, the muddy water will traverse the whole length of the reservoir without losing its identity. On the other hand, if conditions are favorable, mixing of the muddy with

the clear water is produced, and eventual settling of solid particles to the bottom of the reservoir occurs, which tends to fill up the reservoir with silt. For the proper operation and the efficient maintenance of reservoirs, it is highly desirable that the laws of passage of muddy water through fresh water be known.

The other phenomenon is the motion of salty water from the sea into the mouths of large rivers and to points farther upstream. The presence of salty water, especially if mixing is not prevented, becomes a serious problem when the water is used for domestic purposes and irrigation. In such cases it is also desirable that the law of mixing of fresh and salty water be known.

The usual method of obtaining the desired engineering information is to reproduce the condition causing the motion on a small scale in the laboratory. This procedure possesses the advantage of permitting these conditions to be varied at will. However, when the problem arises of passing from the laboratory tests to the actual full-scale behavior of the phenomena, the problem of transference equations comes to the fore. Is the method of transference legitimate? This question ordinarily does not arise where the phenomenon is definitely known to depend on a small number of physical quantities. If, on the other hand, the phenomena are complex, and this is obviously the case for the phenomena of mixing, caution must be exercised. In the main, this is because of the possibility that in the laboratory experiments some crucial quantities may have been ignored, or if recognized, their measurement may have been found impracticable. In the study of the phenomena of mixing in stratified flow, such crucial quantities may well be the magnitude and the origin of the random disturbances. These are difficult to deal with.

In these uncertain cases, a partial analysis of the phenomena must be resorted to; that is, complex phenomena are broken down into component problems and each is studied in its own environment. Among the phenomena of mixing in stratified flow, a partial problem which is readily recognized is the stability of the interface between the liquids of unequal density. The statement of the problem would be: Under what conditions do waves generated at the interface of two liquids fail to be amplified exponentially? This is a mathematical problem and is amenable to analysis, provided the configuration of the motion on the two sides of the interface

is known. Information on this point seems to be lacking, and in the Journal of Research for June (RP1591), Garbis H. Keulegan presents a mathematical derivation of the state of flow on the two sides of the interface.

### VISCOSITY OF WATER

The calibrations of a large proportion of the instruments used for measuring the viscosity of oils, solutions, etc., are referred, directly or indirectly, to the viscosity of water at one or more temperatures. For this purpose it is necessary to have reliable values for the variation of the viscosity of water with temperature, and in certain cases, values for the viscosity in mechanical units, sometimes called absolute viscosity.

A determination of the viscosity of water had been in progress at the Bureau but was discontinued because of the war. When the work was suspended, some results had been obtained, but much remained to be done before the results would have been considered suitable for publication under normal conditions. Since it appears, however, that the results already obtained are probably more accurate than the values at present accepted and in use, it seems desirable to publish a brief note announcing these values. Such an announcement has been prepared in the form of a letter to be published in the American Journal of Physics. In addition to giving the values found at the Bureau, the letter contains a comparison with values found in the literature, and indicates that the new results are in excellent agreement with the best of other measurements.

### THE QUATERNARY SYSTEM SODA-LIME-SILICA-WATER

The soda and potash in portland cements occasionally produce undesirable effects on the properties of cement products. Thus, concrete made of high-alkali cements and aggregate containing reactive siliceous materials, as opal, are known to expand excessively. The role of the alkalies in the various processes of hydration is not fully understood. Information on how they alter the composition of the different reaction products should prove useful in explaining the hydration of cements, both in the presence and absence of "reactive" aggregates. An investigation of the quaternary system soda-lime-silica-water at 25° C. was accordingly carried out by George L. Kalousek, of the Bureau's lime and gypsum section, to provide a portion of the desired data.

As reported in the June Journal of Research (RP1590), the only solid phases found were calcium hydroxide and a soda-lime-silicate gel of variable composition. In the presence of excess calcium hydroxide, the composition of the gel varied between about  $2\text{CaO} : 1\text{SiO}_2 : x\text{H}_2\text{O}$  (with no soda present in solution) and  $1\text{Na}_2\text{O} : 4\text{CaO} : 4\text{SiO}_2 : x\text{H}_2\text{O}$  (soda concentrations of 20 to 150 g of  $\text{Na}_2\text{O}$ /liter). In the absence of excess calcium hydroxide, the ratio of  $\text{CaO}$  to  $\text{SiO}_2$  of the gels decreased with increasing amounts of  $\text{SiO}_2$  in the contact solution.

The study indicated that the  $\text{CaO} : \text{SiO}_2$  molar ratio of the lime-silicate gels in hydrated cement may vary, the extent of variation depending on the alkali content of the cements. These gels will also contain a small amount of alkali. Low-lime alkali-silicate gels, comparable in composition to those found accumulated in voids in expanding concrete, cannot exist in the presence of calcium hydroxide. It may be that the presence of such gels in concrete is possible because, as postulated recently by Hansen, membranes are formed that separate the alkali silicates from the calcium hydroxide.

#### CHANGE IN PRICE OF LIST OF PUBLICATIONS

Notice has been received by the Bureau from the Government Printing Office that the price of Circular C24, the Bureau's list of publications from 1901 to 1925, has been changed from 25 to 35 cents. The complete list up to December 31, 1941 (Circular C24 and two supplements), is, therefore, available by purchase from the Superintendent of Documents, Government Printing Office, Washington 25, D. C., as follows:

Circular C24, 7th edition (covering the period 1901 to June 30, 1925) .....	\$0. 35
1925-1931 Supplement to C24 (covering the period July 1, 1925, to December 31, 1931) .....	. 25
1932-1941 Supplement to C24 (covering the period January 1, 1932, to December 31, 1941, with subject and author indexes covering the period 1901 to 1941) .....	. 50
Complete list .....	1. 10

#### NEW AND REVISED PUBLICATIONS ISSUED DURING MAY 1944

##### Journal of Research<sup>2</sup>

Journal of Research of the National Bureau of Standards, volume 32, number 5, May 1944 (RP1584 to RP1587, inclusive). Price 30 cents. Annual subscription, 12 issues, \$3.50.

##### Research Papers<sup>2</sup>

[Reprints from the February and March 1944 Journal of Research]

RP1574. Measuring the rate of wear of tire treads. Frank L. Roth and William L. Holt. Price 5 cents.

RP1575. A precision apparatus for the rapid determination of indices of refraction and dispersion by immersion. Conrad A. Faick and Bernard Fonoroff. Price 5 cents.

RP1576. Salts of galacturonic acid and their application to the preparation of galacturonic acid from pectic substances. Horace S. Isbell and Harriett L. Frush. Price 10 cents.

RP1577. Note on the macroanalysis of carbon and hydrogen by combustion. Donald D. Wagnan and Frederick D. Rossini. Price 5 cents.

RP1578. Thermal expansion of concrete aggregate materials. Walter H. Johnson and Willard H. Parsons. Price 10 cents.

RP1579. Scale substance of wool. Walton B. Geiger. Price 5 cents.

##### Simplified Practice Recommendations<sup>2</sup>

R31-44. Loaded paper shot shells. (Supersedes R31-39). Price 5 cents.

R204-44. Bronze pop safety valves, and bronze, iron, and steel relief valves. Price 5 cents.

##### Commercial Standard<sup>2</sup>

CS116-44. Bituminized-fibre drain and sewer pipe. Price 5 cents.

##### Technical News Bulletin<sup>2</sup>

Technical News Bulletin No. 325, May 1944. Price 5 cents. Annual subscription, 50 cents.

<sup>2</sup> Send orders for publications under this heading only to the Superintendent of Documents, Government Printing Office, Washington 25, D. C. Subscription to Technical News Bulletin, 50 cents a year; Journal of Research, \$3.50 a year (to addresses in the United States and its possessions and in countries extending the franking privilege; other countries, 70 cents and \$1.50, respectively.)



# MIMEOGRAPHED MATERIAL

## Letter Circulars

[Letter Circulars are prepared to answer specific inquiries addressed to the National Bureau of Standards and are sent only on request to persons having a definite need for the information. The Bureau cannot undertake to supply lists or complete sets of Letter Circulars or send copies automatically as issued.]

- ✓ LC748. Refinishing wood furniture.
- ✓ LC749. Paint and varnish removers.
- ✓ LC750. List of simplified practice recommendations. (Supersedes LC733).

## Weights and Measures News Letter

[Intended primarily for weights and measures officials and manufacturers of weighing and measuring apparatus. No charge is made for this service. All communications should be addressed to the Secretary, National Conference on Weights and Measures, National Bureau of Standards, Washington 25, D. C.]

W&MNL35. Weights and Measures News Letter No. 35, March-April 1944.

## RECENT ARTICLES BY MEMBERS OF THE BUREAU'S STAFF PUBLISHED IN OUTSIDE JOURNALS<sup>2</sup>

Physical concepts: Radiant energy and its measurement, Staff of Photom-

<sup>2</sup>These publications are not obtainable from the Government, unless otherwise stated. Requests should be sent direct to the publishers.

etry & Colorimetry Section and others. Chapter 5 of report of the Optical Society of America Committee on Colorimetry. J. Optical Soc. Am. (57 East 55th St., New York 22, N. Y.) 34, 183 (April 1944).

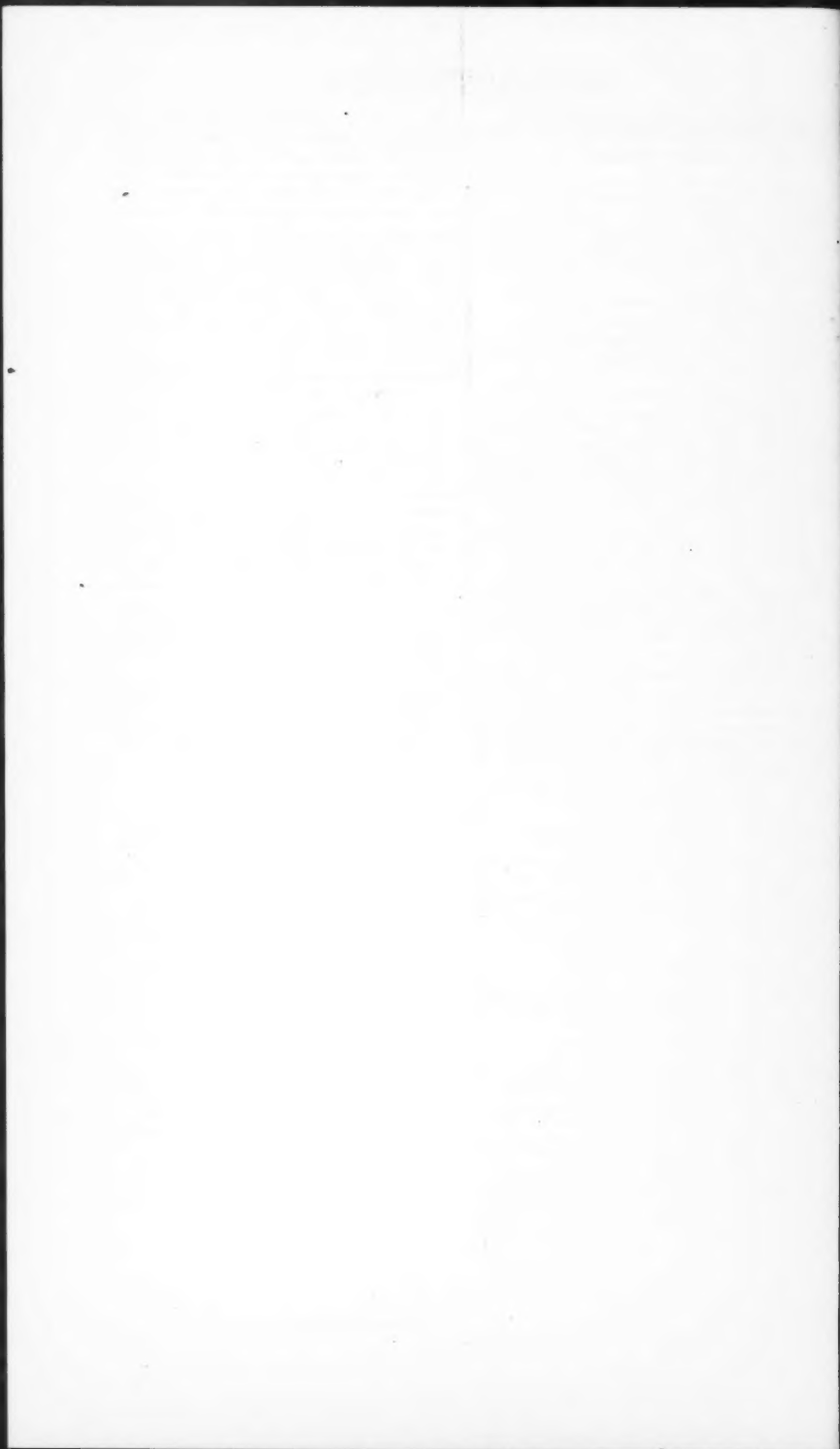
The influence of metallic driers on certain properties of linseed-replacement oils. Charles C Hartman and Eugene F. Hickson. Natl. Paint, Varnish and Lacquer Assn. Circular 673 (1500 Rhode Island Ave. NW., Washington, D. C.) (April 1944).

Factors affecting the thermal expansion of concrete aggregate materials. Willard H. Parsons and Walter H. Johnson. J. Am. Concrete Inst. (7400 Second Blvd., Detroit 2, Mich.) 15, 457 (April 1944).

Effect of hardness of hammers on resistance of vitrified chinaware to chipping and to impact. R. F. Geller and A. S. Creamer. Bul. Am. Ceramic Soc. (2525 North High St., Columbus, Ohio) 23, No. 4, 146 (April 15, 1944).

Simplified practice in long-view planning. Edwin W. Ely. New England Purchaser (80 Federal St., Boston, Mass.) 24, No. 5, 16 (May 1944).

Post-war aids by Standards Bureau. Hugh G. Boutell. Domestic Commerce, (Department of Commerce, Washington 25, D. C.) 32, No. 5, 9 (May 1944).







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